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OFFICE OF
PREVENTION, PESTICIDES
AND
TOXIC SUBSTANCES

Memorandum

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SUBJECT: Initial Biological Benefits Assessment for Azinphos-methyl and Phosmet on Walnuts

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Summary

Walnut growers are relying less on azinphos methyl than in the past to control the key pest, codling moth; however, it remains an important tool. There is significant development toward the use of pheromones, but much work remains. Alternatives to azinphos-methyl include methyl parathion through the 24(c) label, and chlorpyrifos.

If the timing for the application of azinphos methyl to control the codling moth takes place no later than the end of May, extending the REIs on walnuts will not present significant impacts. Irrigation should not require routine entry into the field. However, scouting could be impacted, unless all scouts are certified and can be exempted under the WPS.

Hand harvesting has been replaced by full mechanization in walnuts. Pruning takes place in early October. The initiation of activity to remove mummy nuts is recommended for late January.

No impacts are anticipated related to extending the REIs for the use of phosmet, with the possible exception of those described above for scouting.

Background

California produces 99% of the walnuts grown in the United States and 38% of the world's production. The average farm size, based on USDA Census of Agriculture data from 1997, is 38 acres.

Walnuts are ideally suited to deep, well-drained, fine sandy loam to clay loam soils, but will not produce adequate commercial crops without irrigation in most California growing areas. Flood, furrow, and sprinkler irrigation are predominant. Drip and micro-sprinkler irrigation being used more often in marginal soils. Irrigation takes place from mid-April through October. Orchard soils are generally not cultivated, but herbicide-treated tree rows are common. Mechanized winter pruning is practiced. A smooth orchard floor is necessary to facilitate harvest of walnuts that are shaken to the ground, swept into a windrow, and picked up with pickup machines. All these harvest activities are mechanized. Some orchards are disced and rolled before harvest to insure a smooth, firm surface for harvest.

The Sacramento and San Joaquin Valleys of California are the largest production areas. Acreage is well distributed throughout these regions. The coastal valleys in the counties of Santa Barbara, San Luis Obispo, Monterey, and San Benito also have significant production. Unique areas in the Sierra Foothills and Lake County also have some walnut production. Over 15 varieties of walnuts are grown in the state commercially, with numerous other cultivars being planted on a smaller scale. Selected cultivars are grafted onto rootstocks. The three rootstocks generally used in California are Northern California Black, Paradox hybrid, and English Walnut. Both varieties and rootstocks vary in susceptibility to diseases, nematodes, and insect pests.

Activities in the orchard during the summer months include mowing, summer training young trees, vertebrate pest and weed control, and harvest. Pruning occurs between October and January, and mummy nut removal takes place around February.

Insect Pests that Azinphos-methyl and Phosmet are used to control

Codling moth is the primary/key pest of walnuts and the most economically important pest statewide. Both Azinphos-methyl and phosmet are used to control this pest, although resistance is developing to azinphos-methyl. Methyl-parathion and chlorpyrifos are picking up azinphos-methyl's market share as these organophosphate insecticides are negatively cross-resistant with azinphos-methyl. Novel ways of applying codling moth pheromones and the parasite *Trichograma platneri* may provide some alternative controls for this difficult to control pest. Pheromone mating disruption control programs have been effective in pome fruit for codling moth control when pest populations going into the growing season are kept at low to moderate levels. Heavy codling moth pest pressure is not adequately controlled by the pheromone mating disruption programs. However, consultants and University extension personnel report that early season control of codling moths with azinphos-methyl works to prevent buildup of pest populations and has facilitated the success of the codling moth mating disruption programs. Azinphos-methyl is used because it has been the most effective codling moth material and many beneficial insects have developed some tolerance to it.

Navel orangeworm is also a major walnut pest treated with azinphos-methyl and/or phosmet. As in almonds, navel orangeworm infestations are correlated with the presence of aflatoxins. The USDA Crop Profile indicates that esfenvalerate is the product of choice to control this pest in late season. Early season control with synthetic pyrethroids is disruptive to biological control of mites and is not recommended.

The USDA Crop Profile indicates that phosmet will control walnut husk fly, fall webworm and redhumped caterpillar.

Production Data for Walnuts

Bearing walnut acreage in California in 2000 totaled 193,000 acres, based on USDA NASS data. From 1990-1994, California's average production was 235,600 tons and in 1995, the crop totaled 234,000 tons and was valued at $313,560,000. Over 40% of the California walnut crop is currently being exported. Thirty-five percent of the crop is marketed in shell.

Table 1. Walnuts: Area, Production, and Value of Production in California

U.S./State	Bearing Acreage[2]	Production (million pounds)	Percent of US Production[2]	Value of Production ($1000)
California	193,000	510	99%	$317,220

Source: USDA/NASS Agricultural Statistics 2000.

2. Percent of U.S. production is based on bearing acreage from the 1997 Census of Agriculture. States other than CA listed as containing walnut acreage in the 1997 Census of Agriculture are :AR, ID, IL, IN, IO, KS, MD, MI, NY, NC, OH, OR, PA, TN, VA, and WA. OR is the largest with 1,953 harvested acres reported.

Azinphos Methyl Usage in CA

Table 2 lists the usage of azinphos methyl on walnuts in California. An average of 10% of the California walnut bearing acreage is treated with azinphos methyl per year, and about 33,123 pounds of azinphos methyl are applied. The average number of applications of azinphos methyl per year in California is 1.40 with an application rate of 1.23 pounds per acre per application. See Table 2 for additional information.

Table 2. Usage of Azinphos-Methyl on Walnuts in California.

U.S./State	Percent of Crop Treated	Base Acres Treated [1]	Total Pounds Applied [2]	Average Number of Applications (#/year)	Average Application Rate (lbs/acre)
California	10%	19,000	33,123	1.23	1.40

Source: Table data is a two year average of California Department of Pesticide Regulation estimates of azinphos methyl usage from 1998 and 1999.

1. Base acres treated calculated using percent of crop treated estimates against bearing acreage from Table 1.

Note: The US EPA Quantitative Usage Analysis (QUA) of azinphos-methyl, 4/99, estimates an average of 17% crop treated and 67,000 pounds applied in the U.S. Based on ten years of data and multiple data sources.

2. Total pounds applied calculated using base acres treated, average number of applications per year, and average number of pounds per application.

Table 3 lists the usage of phosmet on walnuts in California. An average of 15% of the California walnut bearing acreage is treated with azinphos methyl per year, and about 113,000 pounds of azinphos methyl are applied. The average number of applications of azinphos methyl per year in California is 1.25 with an application rate of 3.90 pounds per acre per application. See Table 3 for additional information.

Table 3. Usage of Phosmet on Walnuts in California.

U.S./State	Percent of Crop Treated	Base Acres Treated [1]	Total Pounds Applied (lbs) [2]	Average Number of Applications (#/year)	Average Application Rate (lbs/acre)
California	15%	29,000	113,000	1.25	3.90

Source: Table data is a two year average of California Department of Pesticide Regulation estimates of phosmet usage from 1998 and 1999.

1. Base acres treated calculated using percent of crop treated estimates against bearing acreage from Table 1.

2. Total pounds applied calculated using base acres treated, average number of applications per year, and average number of pounds per application.

Note: The US EPA Quantitative Usage Analysis (QUA) of phosmet, 6/99, estimates an average of 9% crop treated and 87,000 pounds applied in the U.S. Based on ten years of data and multiple data sources.

Pest Biology and Control

Codling moth

Codling moth is the most economically important pest in walnuts, with approximately 60% of the acreage susceptible to damage. Those acres of susceptible cultivars require one to three treatments per year to manage this pest.

Damage results from the codling moth larvae boring into the nuts and feeding on the kernel. The moth overwinters on the tree or the soil, laying eggs in the spring that emerge as larvae to enter nutlets. Later developing larvae also enter the nuts to feed on the kernel. There are typically three to (less common) four generations per year. The navel orangeworm uses the entry site in the walnut from the codling moth larvae to access the kernel, encouraging populations of this pest. The codling moth is monitored with pheromone traps.

Although over 250 biological control organisms have been shown to attack codling moth, none are capable of keeping populations below that which causes economic damage. Codling Moth Granulosis virus has been shown to be somewhat effective. It must be ingested by larvae and from 9 to 12 applications are needed each year to cover the long generation time. Timing these treatments is extremely difficult because irrigation scheduling prevents growers from getting into orchards in a timely matter. Also, because walnut trees are large, it is not possible to get the thorough spray coverage with this material necessary for reliable control.

Trichogramma platneri,a codling moth egg parasite, has reduced codling moth damage by up to 70% when 12 weekly releases of 150,000-200,000 per acre per week are released in low to moderate population situations. This level of control is not adequate to prevent a buildup over time and economic damage in most walnut orchards in the state.

At this time codling moth mating disruption is not economically feasible in walnuts because of large tree size and the large volume of air which would have to be permeated with pheromone.

The information reported below is from the Crop Profile for Walnuts in California, and the usage data are from the CA DPR data set from 1995.

Chemical Controls

Approximately 60 percent of walnuts in California are treated from 1 to 3 times (average 2 times) during the growing season for codling moth. Because of multiple treatments in some blocks, the percentages given below will total over 100% (60% of orchards treated X 2 treatments).

Azinphos-methyl - 21 day PHI. Applied, usually once postbloom, to 35% percent of the acreage by ground at an a

rate of 2 lb. a.i. per acre. Some codling moth resistance has recently been documented in walnuts in California. This is still a valuable material in spite of pockets of resistance because the long residual covers the long codling moth hatch. Recent research shows that beneficial insects tolerate this material.

Chlorpyrifos - 14 day PHI. Used primarily for codling moth. Applied at least once to 40% of the walnut acreage by ground at the rate of 1.75 to 2.0 lb. a.i. per acre. Recent data indicate that azinphos-methyl resistant codling moth may exhibit negatively correlated cross-resistance with chlorpyrifos, making this a valuable material in managing organophosphate resistance in walnut pests. It has a short residual and does not cover the entire egg hatch period. Chlorpyrifos also controls walnut aphid, soft scales, and walnut husk fly if properly timed.

Esfenvalerate - 21 day PHI. Applied once postbloom to 5% of the acreage by ground at .05 lb. a.i. per acre. This material is very disruptive to the biological control of mites and should only be used late in the growing season. Also used for navel orangeworm and walnut husk fly.

Permethrin - 1 day PHI. Applied once postbloom to 10% of the walnut acreage by ground at the rate 0.25 lb. a.i. per acre. Extremely disruptive to biological control of mites and not used in the San Joaquin Valley because of this problem. Should only be used late in the season.

Tebufenozide - 30 day PHI. Applied postbloom once or more to 15% of the acreage by ground at the rate of 0.25 lb. a.i. per acre. A high priority material. The need for good coverage and the large size of the trees limits the utility of this material. Fits well in an IPM program.

Diflubenzuron - 28 day PHI. Applied postbloom one or more times to 12% of the walnut acreage by ground at the rate of .25 lb. a.i. per acre (1). A high priority material. May cause aphid outbreaks, but is not common. The need for good coverage and the large size of the trees limits the utility of this material. Fits well in an IPM program. This material cannot be used with *Trichogramma inundative* release or importation of natural enemies.

Phosmet - 14 day PHI. Registered for use on walnuts in 1996. Use data for 1996-97 is not available, but it is believed as much as 25% of the walnuts in California were treated during that period. Use rate is 2.1 to 4.2 lb. a.i. per acre. Less disruptive to beneficial mites and arthropods than some other organophosphates. Used in walnut orchards where proximity to nonagricultural activity and native wildlife habitat necessitate use of a pesticide with minimal impact on non-target organisms. Late season applications will control walnut husk fly and navel orangeworm if properly timed.

Methyl-parathion - PHI 14 days. Received a SLN for walnuts in California in 1997 and use data was not available at the time the Crop Profile was done. Applied postbloom by ground at the rate of 1.5 to 2.0 lb. a.i. per acre. Maximum of 8 lb. a.i. per season. Recent data indicate that azinphos-methyl resistant codling moth may exhibit negatively correlated cross-resistance with methyl-parathion, making this a valuable material in managing organophosphate resistance in walnuts.

It is anticipated that methyl parathion will be applied to significant acreage in response to the development of azinphos-methyl resistant codling moth, particularly in the southern San Joaquin Valley.

Diazinon and **Methidathion** will also control codling moth.

Navel Orangeworm, *Amyelois transitella*:

This scavenger insect attacks a wide range of walnut varieties; feeding directly on the kernel inside the nut. It not only destroys kernels, but may be associated with fungi responsible for aflatoxin. Navel orangeworm larvae cannot enter sound nuts so damage occurs after hull-split and before harvest. Navel orangeworm overwinters as larvae

inside mummy nuts left on the tree and in trash nuts left on the ground. Silver gray moths of the overwintered brood emerge in spring and lay eggs on nuts damaged by codling moth or blight which act as a food bridge for this generation. After hatching, white neonate larvae of the first generation enter nuts damaged by codling moth or walnut blight, making codling moth and blight control extremely important. Larvae mature inside nuts producing large amounts of frass and webbing. Mature larvae are white or pinkish and may reach 5/8 inch in length. After hull-split, adults lay eggs directly on the hull of sound nuts and the tiny larvae enter nuts through the soft tissue at the stem end and do not emerge until they are adults. There are 3 to 4 generations per year. Twenty percent damage is not uncommon in late harvested orchards.

Monitoring: Egg traps are used to monitor navel orangeworm (NOW) and give some indication which blocks should be harvested earliest Egg traps do not work well under high population pressure.

Biological Controls

Two introduced wasps, *Goniozus legneri* and *Pentalitomastix plethoricus*, are established in many areas but are not effective in controlling NOW in walnuts.

Cultural Controls

Control codling moth and walnut blight to eliminate these sources for 1st generation larvae and preclude an early buildup inside the orchard. Shake mummy nuts from trees and flail all sound nuts on the orchard floor to reduce overwintering populations. In addition, good sanitation is a must around hullers, bins, dryers, and buildings where nuts have been handled. Early and rapid harvest, including use of ethephon to promote early harvest, prompt drying, and fumigating will all help reduce damage by NOW.

Chemical

Chemicals are an important part of a 3-step program (good sanitation, early and rapid harvest and effective chemical controls) for managing navel orangeworm in walnuts and provide 50-70 percent reduction if used correctly.

Azinphos-methyl - 21 day PHI. Applied postbloom to 10% of the acres by ground at an average rate of 2 lb. a.i. per acre.

Esfenvalerate - 21 days PHI. Applied postbloom to 19% of the acreage by ground at 0.05 lb. a.i. per acre. Can be used close to harvest. This material is very disruptive to the biological control of mites and should only be used late in the growing season. Also used for codling moth and walnut husk fly.

Carbaryl - 0 days PHI. Applied postbloom to 2% of the acreage by ground at 4 lb. a.i. per acre. Best used late in the season because it causes mite buildup.

Phosmet will also reduce navel orangeworm.

Usage of Azinphos Methyl and Phosmet on Target Pests

The walnut target pests for azinphos-methyl and phosmet are listed in Table 4. An estimated 80% of total azinphos-methyl usage on walnuts is for the control of codling moth while the remaining 20% is used to control the navel orange worm. Total usage of phosmet on walnuts similar to azinphos-methyl with 95% of total usage for the control of codling moth and 5% for the control of the navel orange worm. See Table 4.

Table 4. Target Pests for Azinphos Methyl and Phosmet on Walnuts.[1]

Active Ingredient	Target Pest In Order of Importance (Based on Estimated Usage by Pest [2])	Share of Total Azinphos-Methyl / Phosmet Usage by Pest
Azinphos Methyl	Codling Moth	80%
	Navel Orange Worm	20%
Phosmet	Codling Moth	95%
	Navel Orange Worm	5%

1. Sources: EPA proprietary data.
2. Importance based on the proportion of total azinphos methyl or phosmet usage (total acre treatments) for the control of the target pest.

Azinphos-methyl and phosmet account for about 10% and 15% of the total acre treatments with insecticides for the control of codling moth in walnuts, respectively. The leading insecticide for this crop pest combination is chlorpyrifos with about 35% of the total acre treatments. Other chemicals used for codling moth control include Esfenvalerate with a 15% share of this market combination and methyl parathion with about 10%. The chemicals listed in table 5 represent about 97% of total insecticide treatments for codling moth, according to EPA proprietary data. See Table 5.

Table 5. Leading Insecticides Used for Control of the Codling Moth in Walnuts.

Insecticide - In Order of Importance (Based on Estimated Usage for the Control of Codling Moth)	Share of Total Insecticide Use (Total Acre Treatments) for Control of Codling Moth
Chlorpyrifos	35%
Esfenvalerate	15%
Phosmet	15%
Methyl Parathion	10%
Azinphos-methyl	10%
Permethrin	5%
Tebufenozide	5%
Methidathion	2%
Propargite	2%
Diazinon	2%

Source: EPA proprietary data.

Azinphos-methyl and phosmet account for about 20% and 10% of the total acre treatments with insecticides for the control of the navel orange worm in walnuts, respectively. The leading insecticide for this crop pest combination is chlorpyrifos with about 35% of the total acre treatments. Other chemicals used for control of navel orange worm include Esfenvalerate with a 10% share of this market combination and tebufenozide with just over 5%. The chemicals listed in table 6 represent about 95% of total insecticide treatments for the navel orange worm, according to EPA proprietary data. See Table 5.

Table 6. Leading Insecticides Used for Control of Navel Orange Worm on Walnuts.

Insecticide - In Order of Importance (Based on Estimated Usage for the Control of the Navel Orange Worm)[1]	Share of Total Insecticide Use (Total Acre Treatments) for Control of the Navel Orange Worm[1]
Chlorpyrifos	35%
Azinphos-Methyl	20%
Esfenvalerate	10%
Phosmet	10%
Tebufenozide	5%
Propargite	5%
Methyl Parathion	5%
Methidathion	< 5%
Fenbutatin Oxide	< 5%
Permethrin	< 5%

Source: EPA proprietary data.

Impacts

REI s for Phosmet and Azinphos-methyl:

Phosmet			Azinphos-methyl	
Current label REI	Registrant proposed REI	PHI	Current label REIs	PHI
24 hours	37 days	14 days	14 days for hand harvesting; 2 or 3 days for all other activities	21 days

Walnut growers are relying less on azinphos methyl than in the past to control the key pest, codling moth; however, it remains an important tool. There is significant development toward the use of pheromones, but much work remains. Alternatives to azinphos-methyl include methyl parathion through the 24(c) label, and chlorpyrifos.

If the timing for the application of azinphos methyl to control the codling moth takes place no later than the end of May, extending the REIs will not present significant impacts. Irrigation should not require routine entry into the field. However, scouting could be impacted, unless all scouts are certified and can be exempted under the WPS.

Hand harvesting has been replaced by full mechanization in walnuts. Pruning takes place in early October. The initiation of activity to remove mummy nuts is recommended for late January - February.

No impacts are anticipated for Phosmet, with the possible exceptions of scouting, as described above. Please refer to the occupational and residential human health risk assessment on the Agency's website (http://www.epa.gov/pesticides/op) for information concerning the worker risks associated with the restricted entry

intervals for this chemical.

Sources

USDA Crop Profile for Walnuts in CA. Web address: http://pestdata.ncsu.edu/cropprofiles/docs

Walnut Production Manual, 1998. Ramos, David E., Technical Ed. Various authors.